FLORIDA POLYTECHNIC UNIVERSITY

Capstone Design

Course Overview and Preview

M. Bohm, Fall 2024

Capstone Overview

Big Picture

- Required by accrediting agency (ABET) to be a culminating design experience
  - For the experience to be culminating only seniors or those near graduation are allowed to enroll in the course
    - Students have already taken a majority of their classes
- Final piece of their educational experiences, preparing them to step into the workforce (or graduate school)

Capstone Overview

Program Description

The Capstone Design Course sequence at Florida Polytechnic University represents the pinnacle of the STEM educational experience. It offers students from diverse majors—including computer science, data science, electrical engineering, computer engineering, cybersecurity engineering, environmental engineering, business analytics, mechanical engineering, applied mathematics, engineering physics, civil engineering, and industrial engineering—the opportunity to work collaboratively on real-world projects. This program is meticulously designed to closely mimic the industrial environment, ensuring that graduates are well-prepared for professional challenges.

Capstone Overview

Majors and Teaming

- Capstone is offered in all of our degree granting programs
  - Applied Mathematics, Computer Engineering, Computer Science, Electrical Engineering, Engineering Physics, Environmental Engineering, Data Science & Business Analytics, Cybersecurity Engineering, and Mechanical Engineering
- Teams can be comprised by students of a single discipline or by students from several different disciplines
- Team sizes can range from 2-3 students to 8-12 students depending on the scope of the project
- Students are assigned to teams after providing preferences and taking a personality survey (MBTI/HIGH5)

Capstone Overview

Timeline (Fall)

- Weeks 1-4: Foundational Teaching and Demonstration
  - Introduction and Design Thinking: Students are introduced to the course objectives, design thinking principles, and systematic problem-solving techniques. This phase includes case studies of successful projects and covers empathy, problem definition, ideation, prototyping, and testing.
  - Public Speaking: Using Dale Carnegie's high-impact speaking materials, students develop essential public speaking skills.
- Weeks 5-10: Project Assignment and Concept Development
  - Project Assignment and Initial Planning: Students are assigned interdisciplinary projects reflecting the diverse challenges within their fields. Teams are formed, and initial project planning begins.
  - Conceptual Design and Ideation: Students engage in iterative ideation, developing and refining their ideas while applying **technical principles that they learn throughout their degree**. This phase emphasizes problem decomposition and customer-centric solution evaluation.
- Weeks 11-16: Prototyping and Preliminary Testing
  - Alpha Prototype Development: Teams create alpha prototypes to communicate their chosen direction. Feedback is gathered, and necessary adjustments are made.
  - Testing and Validation: Prototypes are tested and validated against defined criteria. Students refine their designs based on test results and prepare for final presentations.

Capstone Overview

Timeline (Spring)

- Weeks 1-6: Review, Planning, and Standards Integration
  - Review and Planning: Alpha prototypes are reviewed, and plans for refinement are developed. Students integrate applicable industry standards and codes into their project designs.
  - Detailed Design and Engineering: Design refinements are made based on feedback and industry standards. Students engage in detailed engineering and problem-solving activities.
- Weeks 7-12: Prototype Development and Impact Assessment
  - Beta Prototype Development: Teams develop beta prototypes and conduct thorough testing and validation. Emphasis is placed on ensuring prototypes meet real-world conditions.
  - Broader Impacts and Ethical Considerations: Students assess the ethical, environmental, economic, and social implications of their projects, ensuring a comprehensive understanding of the broader impacts.
- Weeks 13-16: Final Refinements and Professional Presentation
  - Final Adjustments: Final adjustments are made based on broader impacts and testing results. Students ensure compliance with industry standards and codes.
  - Documentation and Reporting: Comprehensive project documentation and reports are finalized.
  - Professional Presentations: Students prepare for and deliver final presentations to faculty and external evaluators, showcasing their work and honing their professional communication skills.

Capstone Overview

Timeline

- Fall Semester Culmination:
  - The fall semester concludes with final presentations in class and to faculty panels, where students showcase their project outcomes and refine their presentation techniques, including public speaking and visual communication. Comprehensive project reports are submitted, documenting the design process and reinforcing critical thinking and professional communication skills.
- Spring Semester Culmination:
  - The spring semester wraps up with presentations to both faculty panels and external industry evaluators (showcase), highlighting the final iterations of student projects. Students demonstrate how they've integrated feedback and adhered to industry standards, while submitting comprehensive reports that prepare them for the transition from academia to professional practice.

Syllabus Items

Course Learning Outcomes

- **Apply Systematic Problem-Solving Processes**: Understand and effectively utilize a systematic approach to identify, analyze, and solve complex problems.
- **Execute Effective Planning and Scheduling:** Develop and implement detailed project plans and schedules to ensure timely and efficient project completion.
- **Problem Decomposition:** Break down large, complex problems into manageable subsets to facilitate easier analysis and solution development.
- **Customer-Centric Solution Evaluation:** Assess potential concepts and solutions from the perspective of customer needs and requirements, ensuring alignment with their expectations.
- **Concept Selection and Finalization:** Select the most appropriate concept or solution through a structured evaluation process and finalize the approach to address the given problem.
- **Testing and Validation:** Conduct thorough testing and validation of the final solution to ensure it meets the defined criteria and performs as expected in real-world conditions.
- **Professional Communication Skills:** Demonstrate proficiency in professional communication, including writing detailed reports, delivering oral presentations, creating posters, and utilizing multimedia tools.
- **Professional Team Skills:** Exhibit strong professional skills in teamwork, leadership, and team management, contributing effectively to group efforts and achieving common goals.
- **Awareness of Broader Impacts:** Understand and consider the broader impacts of the selected solution, including ethical, environmental, economic, and social implications.

Syllabus Items

Attendance Policy

- Students in face-to-face (this includes labs and C-courses) courses are expected “to attend all of their scheduled University classes and to satisfy all academic objectives as defined by the instructor” (University Policy, FPU-5.0010AP).
- Attendance at all class meetings is expected. Absence does not excuse a student from material covered or any activity done on that day, nor does it extend a deadline.
- Students should inform the instructor as soon as possible if an absence is expected. The instructor should be contacted as soon as possible if an absence was due to an unforeseen emergency. Documentation may be required in either case.
- Attendance is mandatory during presentation days (when your team or other teams present). If you are not present during any presentation day you will not receive credit for that presentation milestone (In Class or Panel Presentations).

Syllabus Items

Email Policy

Emails must be sent from your Florida Poly email account to the Florida Poly email address of the instructor. Please allow up to 36 hours on weekdays for a response, after which you may send a follow-up email. Emails must be composed in a professional manner with a greeting, signature, and in an organized fashion. Start the subject line with "[Capstone – TEAM XYZ]" for a quicker response time. **NO CANVAS Messages.**

Syllabus Items

Professional Development Requirement

As an integral component of the Capstone Design Program, all students are required to participate in professional development modules focused on career and graduate school preparedness. These modules are designed to equip students with essential skills and knowledge for their professional journey, whether they choose to enter the workforce or pursue further academic endeavors. Topics covered include resume building, interview techniques, networking strategies, and graduate school application processes. Participation in these modules is mandatory unless a student can provide documented proof of employment or acceptance into a graduate program. Once such proof is submitted and verified, the student may opt out of the remaining professional development modules, having demonstrated readiness for their next career or academic step.

Syllabus Items

Project Placement and Team Dynamics

- Students are placed on project teams based on a survey they complete, which reports their skills and other relevant attributes. Faculty members then collaborate to align student skills with the needs of the various projects. This process ensures that each project is staffed with a team capable of tackling the specific challenges it presents.
- In astronomically extreme cases, a student may be removed from a project team. Reasons for removal could include, but are not limited to, unprofessional behavior toward team members, faculty, or sponsors, or severe personality conflicts that cannot be resolved. The decision to remove a student from a team will be made by the Director of the Capstone Program in consultation with the Capstone faculty.
- If a student is removed from a project, they will be assigned alternative tasks to satisfy the remaining course requirements. These alternative tasks will be determined by the course instructor and the program director. Students removed from a project will likely not be allowed to present at the Capstone Showcase.
- Additionally, in other extreme cases, entire teams or individual team members may be prohibited from presenting at the Capstone Showcase. Such cases may involve academic dishonesty, intellectual property, or copyright issues.

Syllabus Items

Project Funding

Funding for projects is allocated based on various factors including but not limited to project scope, required deliverables, and project health. All purchase orders should be placed through their capstone project mentor. If a student makes purchases directly, or through avenues that are not their capstone mentor, it is considered a donation to the project. Students will not be reimbursed for project expenses.

Course Content

Timeline (1)

Week 1 (August 21, 23, 26)

- Course introduction and Design Thinking overview
- Interdisciplinary teamwork and real-world problem solving
- Introduction to the 5 stages of Design Thinking
- Case studies and Mini-Challenge preparation

Week 2 (August 28, 30, September 4)

- Techniques for understanding user needs
- Problem definition methods and activities
- Brainstorming and idea generation techniques

Week 3 (September 6, 9, 11)

- Concept selection and evaluation techniques
- Prototyping methods and case studies
- Testing, validation, and design of experiments

Week 4 (September 13, 16, 18)

- Design embodiment: CAD, simulations, UI mockups
- Collecting accurate feedback: Metrics and analytics
- Public speaking and presentation skills

Course Content

Timeline (2)

Week 5: Project Assignment and Initial Planning

- Assignment of capstone projects
- Initial project planning and team roles

Week 6-8: Conceptual Design and Ideation

- Developing concepts and selecting the best solutions
- Iterative ideation and refinement

Week 9-10: Prototyping and Alpha Prototype Development

- Creating alpha prototypes for communication of the selected direction
- Gathering feedback and making necessary adjustments

Week 11-12: Testing and Validation

- Testing alpha prototypes and validating design choices
- Iterative improvements based on test results

Week 13-14: Professional Communication and Presentation Preparation

- Finalizing project documentation and preparing presentations
- Techniques for effective communication and public speaking

Week 15-16: Final Presentations and Reports

- Final project presentations to faculty and peers
- Submission of detailed project reports

Design Thinking

Overview

Design thinking is a human-centered approach to problem-solving that emphasizes empathy, creativity, and iteration. It focuses on understanding the needs of users, redefining problems, and developing innovative solutions through a collaborative and iterative process.

- **User-Centric Solutions**: By prioritizing empathy and deep user understanding, design thinking ensures that solutions are tailored to meet the actual needs of users, leading to more effective and impactful outcomes.
- **Iterative Process**: Design thinking is iterative, meaning that solutions are continuously tested, refined, and improved based on feedback. This leads to more robust and well-developed final products.
- **Cross-Disciplinary Collaboration**: Design thinking thrives on collaboration, bringing together diverse perspectives from various disciplines. This holistic approach often leads to more comprehensive and effective solutions.

Design Thinking

5 Stages

- Empathize
- Define
- Ideate
- Prototype
- Test

Design Thinking

5 Stages - Empathize

- Purpose:
  - Gain a deep understanding of users' needs, experiences, and motivations.
  - Set aside personal assumptions to obtain genuine insights into users and their problems.
- Key Activities:
  - Conduct interviews and surveys to gather firsthand information.
  - Observe users in their natural environment to understand context and behavior.
  - Engage with users through empathy maps and journey mapping.
- Outcomes:
  - Comprehensive understanding of user perspectives and pain points.
  - Identification of user needs and desires that inform the design process.

Design Thinking

5 Stages - Define

- Purpose:
  - Clearly articulate the core problem based on insights gathered during the Empathize stage.
  - Create a focused problem statement that guides the design efforts.
- Key Activities:
  - Synthesize and analyze data collected from user research.
  - Identify patterns, themes, and insights from user feedback.
  - Formulate clear and actionable problem statements (Point-of-View statements).
- Outcomes:
  - Well-defined problem statement that addresses user needs.
  - Establishment of criteria for successful solutions.

Design Thinking

5 Stages - Ideate

- Purpose:
  - Generate a broad range of creative and innovative solutions to the defined problem.
  - Encourage free thinking and exploration beyond obvious solutions.
- Key Activities:
  - Conduct brainstorming sessions to explore diverse ideas.
  - Utilize ideation techniques such as mind mapping, SCAMPER, and brainwriting.
  - Encourage collaboration and build on others' ideas to expand solution space.
- Outcomes:
  - Collection of potential solutions and concepts.
  - Identification of promising ideas for prototyping.

Design Thinking

5 Stages - Prototype

- Purpose:
  - Transform ideas into tangible, testable versions to explore solution viability.
  - Facilitate understanding, experimentation, and communication of concepts.
- Key Activities:
  - Create low-fidelity prototypes such as sketches, models, or storyboards.
  - Develop interactive prototypes using tools appropriate to the solution (e.g., digital mockups, physical models).
  - Iterate prototypes based on immediate feedback and observations.
- Outcomes:
  - Visual and functional representations of ideas.
  - Identification of strengths, weaknesses, and areas for improvement in solutions.

Design Thinking

5 Stages - Test

- Purpose:
  - Evaluate prototypes by collecting feedback from users and stakeholders.
  - Refine and improve solutions through iterative testing cycles.
- Key Activities:
  - Conduct user testing sessions to observe interactions and gather feedback.
  - Utilize surveys, interviews, and usability studies to assess effectiveness.
  - Analyze results and identify necessary refinements or pivots.
- Outcomes:
  - Validated insights into how users interact with and perceive the solution.
  - Improved and user-centered designs ready for implementation.

Case Study

IDEO - Shopping Cart Project

https://www.youtube.com/watch?v=izjhx17NuSE

- IDEO, a global design company, was tasked with redesigning the traditional shopping cart to improve user safety and convenience.
  - **Empathize**: IDEO's team observed and interviewed users in grocery stores to understand the pain points with existing shopping carts, such as safety concerns and inefficiencies in use.
  - **Define**: The team identified the core problems: difficulty in maneuvering, lack of safety features, and inefficient space usage.
  - **Ideate**: Through brainstorming sessions, the team generated numerous ideas, from collapsible carts to modular storage solutions.
  - **Prototype**: Multiple prototypes were developed, including a cart with modular baskets and improved ergonomics.
  - **Test**: These prototypes were tested in real-world scenarios, with users providing feedback on usability and functionality, leading to iterative improvements
- A new, innovative shopping cart design with increased safety, modular storage, and enhanced user experience, demonstrating the power of Design Thinking in solving everyday problems.

Case Study

Airbnb - Business Model

- In its early days, Airbnb struggled with slow growth and inconsistent user experiences, leading the founders to apply Design Thinking to revamp their business model.
  - **Empathize**: The founders stayed in the homes listed on Airbnb to understand the user experience from both the host and guest perspectives.
  - **Define**: They identified the core issues: poor-quality photos of listings and the need for trust and transparency between hosts and guests.
  - **Ideate**: Solutions included hiring professional photographers to take high-quality photos and introducing a review system to build trust.
  - **Prototype**: Airbnb tested these ideas by offering free photography services to hosts and implementing the review system on a small scale.
  - **Test**: Feedback from hosts and guests showed significant improvements in bookings and user satisfaction, leading to wider implementation.
- Airbnb's application of Design Thinking led to a significant increase in user engagement and growth, transforming the company into a global leader in the travel and hospitality industry.

Case Study

IBM - Watson AI

- IBM applied Design Thinking to develop and refine its Watson AI platform, focusing on creating user-centered solutions.
  - **Empathize**: IBM engaged with potential users across industries, including healthcare and finance, to understand their challenges and needs.
  - **Define**: The team identified the need for an intuitive, powerful AI tool that could assist with decision-making and data analysis.
  - **Ideate**: Multiple ideas were explored, from natural language processing to machine learning applications tailored to specific industries.
  - **Prototype**: IBM developed prototypes of Watson's capabilities, such as its ability to understand and process large volumes of data.
  - **Test**: These prototypes were tested with real users, leading to refinements in Watson's interface and functionalities based on user feedback.
- IBM Watson became a leading AI platform, adopted by industries worldwide for its ability to process information and assist with complex decision-making, driven by a user-centered approach through Design Thinking.

Design Thinking Assignments

Individual Component of the Grade

- Six (or so) individual assignments aligned with the 5 stages of Design Thinking: Empathize, Define, Ideate, Prototype, and Test.
- Assignments will gradually increase in scope and complexity, each building on the previous one.
- Early assignments will help you master each stage of Design Thinking independently.
- Later assignments will combine multiple stages, preparing you for complex problem-solving.
- These assignments will equip you with the essential skills needed for effective collaboration.
- When placed into project teams, you'll apply these skills to tackle larger, interdisciplinary challenges.